concepts are quite novel, will be able in general to follow the author's reasoning.

Howard C. Warren
Princeton University,
February 8, 1916

The Permo-Carboniferous Red Beds of North America and Their Vertebrate Fauna. By E. C. Case. Carnegie Institution of Washington.

In this monograph Dr. Case has summarized our knowledge to date of the vertebrates from these Permo-Carboniferous beds, which, for a period of over forty years, have been yielding remains of essential interest to paleontology; because the beds, laid down at a time when the amphibians were dominant and the reptiles were in the transitional stages, have preserved the most complete skeletons of these early vertebrates, and it is essential to know these Cotylosaurs, Pelycosaurs, etc., in order to attain a correct idea of the further development of the reptiles and the ancestry of the mammals.

His careful description of the beds and localities invites and clears the way for those who shall follow and collect in these beds, the tedious search for favorable localities and horizons, which hampered the pioneers in this field, being removed by the submission of all this data to the public; and it is a hard field, the fossils being scarce and fragmentary. Then his conclusions from the character of the beds as to the climates and environment are a great aid in the efforts to interpret evolution.

Case gives the range of this fauna as from the Pittsburgh Red Shales in the middle of the Upper Pennsylvanic (Missourian) to the top of the Clear Fork, which is about the middle of the Permic, as described by Schuchert. At this point in time the dominance of this fauna ends in America, though in Europe, it, or an equivalent fauna, runs up into the Triassic.

It is shown that all the amphibians of the fauna are carnivorous, the reptiles partly carnivorous, partly molluscivorous, and partly insectivorous. None were adapted to marine life; none were far advanced even toward fresh water life; but the fauna is typically one of the estuaries, swamps, alluvial plains and woodlands.

The eighth chapter presents summary descriptions of the best-known genera, illustrated by 23 restorations, which impress the reader with the heavy, slow-moving character of most of these animals, though the drawings leave something to be desired in life-like appearance.

An appendix gives a description of the Brier Creek Bone Bed and its fauna, the locality which has yielded the richest finds of Permo-Carboniferous vertebrates. Some twenty plates show detail photographs of the beds and fossiliferous strata, which will aid any one studying the conditions of deposition, or going into this field, so that with the minimum of experience they can get the best results.

As a whole the volume is one which will ably serve any student of the Permo-Carboniferous, as it brings him up to the present, and will long serve as the starting point for further studies of these beds.

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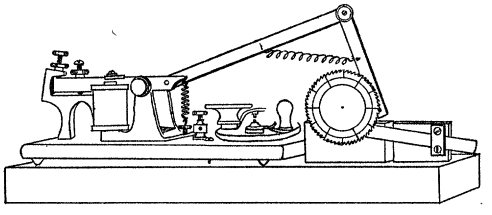
SPECIAL ARTICLES

AN ELECTRIC COUNTER FOR DETERMINING THE RATE OF A FREE-SWINGING PENDULUM

A heavy pendulum, vibrating through small arcs, and unconnected with clockwork or escapement, possesses several advantages for recording time in graphic experiments. It is simple, and easy to construct, and is more accurate than some more complicated apparatus used for this purpose. Its especial merit is that its consecutive swings are so perfectly isochronous that it can be employed for testing tuning-forks and other vibrating recorders. In testing tuning-forks and in similar work it is absolutely necessary that the time intervals should be equal. As the vibrations of the pendulum of a clock are liable to be affected by irregularities in the action of the motive power, it is possible that they may not be perfectly isochronous when their number in a considerable period of time is correct. This objection does not apply to the free-swinging pendulum.

The chief obstacle in employing a free-swinging pendulum for graphic purposes is the difficulty of determining its rate. The methods of coincidence devised by physicists necessitate the use of a standard clock, and are somewhat complicated. The writer has constructed a simple apparatus for recording the exact number of beats in the period tested, which has given very satisfactory results. The figure shows the essential details of its construction.

The common base of a telegraphic sounder and key is fastened to a larger board. A counter for registering rotation is screwed to a small block, with its axis at right angles to the lever of the sounder. A brass disc with 60 ratchet teeth is attached to the end of the axis. The movements of the lever of the sounder are



communicated to the toothed wheel by two strips of steel which are connected by a joint. The first strip is fastened to the right-hand end of the lever with a screw. A pin projects at right angles from the lower end of the second strip. This pin is shaped to fill the interval between two teeth, and acts both as a pawl and an index. The front face of the disc is divided by radial lines which mark the position of every fifth tooth, the tenths being designated by longer lines.

The sounder is placed in the circuit, which is periodically closed and opened by the pendulum that is being tested. When the lever is pulled down by the electromagnets the disc is rotated to the extent of one tooth, and every complete rotation of the wheel is registered by the counter. To prevent the disc from advancing too far when it is suddenly pulled forward, and from recoiling when the pawl moves backward, a clock spring, fastened to a second block, is pressed against the back of the wheel by a screw with a milled head passing through the block. This screw does not appear in the sketch. The degree of pressure required by varying conditions is regulated by experiment. The index is pressed against the wheel by a delicate spiral spring stretched across the angle of the arm. The extent of movement of the arm is regulated by the two screws at the left of the figure. The dropping of the pawl is due to the spring attached to the end of the lever, the tension of the spring being regulated by the screw to which its lower end is fastened. Pieces of paper are placed between the armature and the magnets in order that the lever may return with sufficient rapidity to its original position. When it is desired to use the sounder without the counter, the screw which clamps the arm to the lever is loosened, the arm elevated a little, and the screw again tightened.

The electric counter should be used with a reliable time-piece indicating seconds. The zero mark on the disc is set opposite the index-pawl. When the second hand of the watch is in the desired position, the horizontal lever to which the right hand knob is attached is thrust beneath the spring, which closes the circuit. While the instrument is in operation, the instant when the zero notch is closed by the index is noted from time to time. If at the end of an hour no variation between the indications of the disc and the watch can be detected, the seconds pendulum is considered accurate enough for testing purposes. It should have an error less than one half second in an hour. In using this coincidence method in regulating the rate of the pendulum it is not necessary to read the counter. The counter is only indispensable in finding the number of vibrations when the rate is unknown.

The seconds pendulum which I have employed in my experiments oscillates upon knife-edges of hardened steel, and has a bob weighing 2.4 kilograms. A platinum wire in the lower end of the rod makes contact periodically with a globule of mercury. The length of the tangent of one degree of arc described by the wire in the end of the rod is two centimeters. By holding a millimeter scale horizontally by

the side of the contact it is easy to displace the pendulum one degree, making the arc of vibration two degrees, which is sufficiently great for testing the apparatus an hour.

As the tuning-fork is the standard instrument for measuring and recording short periods of time in physical and physiological experiments, it is very desirable that its exact rate of vibration should be ascertained under the conditions to which it is subjected. It is necessary to employ the graphic method to do this successfully, for the friction and weight of the writing point are liable to affect the rate. A record of considerable length should be taken to minimize the errors due to irregularities in the action of the electric contact. In my own work the smoked paper for the tracing envelops a light aluminium drum which is rapidly rotated by hand. The drum is mounted on a steel axis with a spiral groove cut in it. A pin projecting into the groove causes the drum to rotate in a spiral. As the spiral movement allows long records to be taken, the mean number of vibrations for a considerable period can be ascertained. The motion by hand is very satisfactory, as the rate of rotation can be varied as required. The time-marker in the circuit of the pendulum should write only a few millimeters from the tracing of the fork. In order to do this it is necessary that the axis of the marker should make an angle with that of the fork. I use a clamp for this purpose which holds the object in any position, and permits a delicate adjustment of the writing point. The records that have been obtained with the apparatus have been very regular; variations of small fractions of a vibration were easily detected in them.

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SECTION M, AGRICULTURE

THE second meeting of the Section of Agriculture was held in Townsend Hall, Ohio State University, Columbus, December 28, 1915. The sessions were presided over by the vice-president of the section, Dean E. Davenport, of Illinois. The two features of the meeting were the address of the retiring vice-president, Dr. L. H. Bailey, upon "The Forthcoming Situation in Agricultural Work," already published in SCIENCE,[1] and a symposium on "The Relation of Science to Meat Production." The latter was participated in by five speakers who presented various phases of the subject. These papers brought out clearly the complicated and many-sided nature of the problem of meat production and the part which science is playing in promoting, safeguarding and rationalizing the industry.

The symposium was led by President W. O. Thompson, of Ohio State University, who defined "The Nature of the Problem." The background of it lies in the fact that the people of this country have been a meat-eating people for many generations, and any limit to the supply or any excessive cost calls forth widespread protest. The problem of meat production was defined to be largely an economic one in farm management. It has been affected by the numerous changes in agricultural conditions over the country, the extension of farming in the west, the increase in the tenant system, and the development of the dairy industry, even in the vicinity of small towns, all of which have affected the raising and fattening of beef cattle.

The large risk sustained in live-stock keeping has contributed another angle, as has also the problem of advantageous marketing. The problem of maintaining the requisite meat supply is not a haphazard one, but includes very definite phases, such as its relations to systems of farming and to the maintenance of soil fertility, the maintenance of health of live stock to reduce the risk, provision of adequate marketing facilities and conditions, and the intelligent feeding and handling of meat animals. The point was emphasized that the taste for meat has been struggling for existence at the expense of the farmer, and that consideration of the problem of continued supply must be based on broad considerations, in the firm belief that the laborer shall receive his reward.

President H. J. Waters, of the Kansas Agricultural College, enumerated some of the ways in which science may help live-stock farming, as by showing the farmer how a surplus of feed may be carried over, in the silo for example, to equalize the feed supply from year to year; by the proper balancing of feeds, a knowledge of the values of

[1] 1916, SCIENCE, N. S., Vol. XLIII., p. 77.